PROGRESS REPORTS

FROM

EXPERIMENT STATIONS

SEASON 1959-60

REPUBLIC OF THE SUDAN

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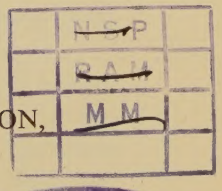

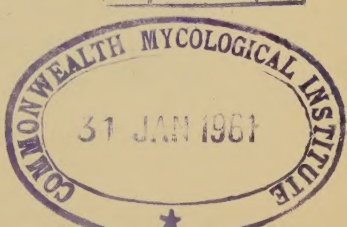

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WAD MEDANI, GEZIRA

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REPUBLIC OF THE SUDAN

COTTON BREEDING STATIONS
PROGRESS REPORT FOR THE SEASON 1959-60

	Planting dates	*Picking dates*
Gezira	Mid August to mid September.	January to March.
Gash	Late August to late September.	Mid January to April.
Tokar	Early September to mid October.	January to May.
Kordofan	Mid June to mid August.	Mid October to February.
Zeidab	First half May.	September to December.
Equatoria	Mid May to August.	October to mid February.

Introductory Note

BY

M. F. ROSE

The main problems, both agricultural and economic, facing the Sudan and its cotton crop remain virtually unchanged since the 1958-59 season: these were discussed in some detail in the previous season's report. However, two major changes have intruded themselves into the general economy of the country and may well cause some re-orientation of policy: these are the increase of the water quota following the Nile Agreement with Egypt in 1959 and the establishment of spinning mills within the Sudan itself.

With the rapid expansion of the area under irrigation, surplus water cannot be envisaged in the pre-Roseires Dam period, so that the need remains for water conservation and experiments with shorter-period types, but the establishment of a spinning and weaving industry in the country adds new problems. If the original mill intake is to be 60,000 bales a year, expanding to double this volume, then both source and quality of supply have to be given consideration. An initial intake of 60,000 bales would virtually take the whole of the Sudan's American crop leaving no surplus for export: to cope with double this intake would imply a rapid expansion of the commercial crop or the import of lint from outside sources. If a short coarse cotton is to be spun to low counts, then yield is of primary importance. The ultimate policy may be one of diversification of the rainfed crop, a high yielding type to meet internal requirements and a quality type for export. This, however, calls for a striking increase in the rainfed area, which is unlikely with falling cotton prices and consequent competition from alternative cash crops such as groundnuts and sesame.

Against this background the policy of diversification of cotton varieties continues. On the American side the range is from Punjab 268F to Wilds Sus 16/1, a range which includes the new synthetic types BAR HOP 11, BAR HOP 7, BAR Wilds 40 and BAR Wilds 36. The gap in yield between the high yielding and the better quality types has been bridged by BAR HOP 11. This cotton, with an

increased yield of 25%, has again been praised by all visiting buyers for its quality and will replace the low yielding, high quality type BAR 11/7 as soon as sufficient seed is available. The range in Egyptian types has been extended from the coarser Ashmounis (Z10 and A34) through the standard BAR S and L types to BAR Karnak and beyond to MSI 2. Four types of Pima S1 are being sorted and assessed, and segregates from the cross BAR 14/25 × Pima S1 show great promise. With the exception of a type equivalent to Giza 45 (of limited demand) it would appear that all future requirements are adequately covered. The cotton thread industry has shown great interest in BAR HOP 11 Family 9, and it may well be that in the future this selection will be used as a cheaper substitute for Giza 45.

Although blackarm has virtually disappeared from the commercial crop, the transfer of B_2B_6 and $B_2B_3B_6$ to all current and probable commercial types continues. Strains carrying these gene combinations with lint quality equivalent to that of the susceptible commercial varieties have been isolated. Although their yields are slightly lower, experiments have indicated that closer intra-row spacing could remedy this. If the peculiar form of blackarm attack of the 1956-57 season recurs and spreads, then such types can be utilized to give near-immunity to the commercial areas.

From the crosses of B_2B_3 S with L, types have emerged superior in yield and quality to the parents and it is hoped that the transfer of leafcurl resistance from the L type to the BAR Sakels has been effected. These selections will be further tested at Shambat under conditions of maximum whitefly infestation. If resistance has been imparted to the S type, then an all-important step has been taken in controlling by plant breeding the second most serious cotton disease of the Sudan.

Further evidence has been accumulated to indicate that a varietal trend towards lateness over the years is one of the reasons for grade deterioration. To counteract this, selection for earliness in BAR XL1 and BAR 14/25 has been undertaken and, in addition, the earliness of Pima S1 has been transferred to BAR 14/25 and that of BAR 14/25 to the L type (B_2B_3 S × L crosses). Changes in inherent quality, in addition to earliness and grade, are likely to result from this work.

The production of the BAN series provides another source of variability within the BAR Sakels. The appearance of 'white' lint in segregates could be of commercial importance and the reduction of fuzz cover has a practical significance in increasing the rate of ginning.

Detailed work continues on the genetics of hairiness within *hirsutum* and *barbadense* and in the species cross. From such a comprehensive survey, data of practical significance should emerge which could help to clarify the relationship between hairiness and

quality. If American types are to be grown extensively in the Gezira, protection against devastating jassid attack will be absolutely essential.

Despite the absence of a full-time pathologist at Shambat, progress has been made in the elaboration, standardization and testing of the newer techniques for transmitting bacterial blight in both the field and glasshouse: trash and inocula from different sources at varying concentrations have been tested against various genetic backgrounds of resistance.

Staff

Following the retirement of Dr. S. O. S. Dark from the Corporation's service in mid May 1960, Mr. J. H. Saunders has taken over the responsibilities of the Shambat station. The staff position has been maintained there by the arrival of Mr. R. E. Gunn in July 1960. Wad Medani is still one officer short of normal requirements but little can be done in this matter until housing becomes available.

Visitors

Mr. D. F. Ruston, Director of the Empire Cotton Growing Corporation, visited the Sudan from 12th to 17th December.

As part of an extensive survey of cotton ginning methods in North and East Africa, Mr. L. H. C. Tippett travelled widely in the Sudan between 6th and 24th February. Private and commercial roller ginning factories were inspected as well as saw gins of the Nuba Mountains area.

Mr. J. M. Munro from Nyasaland visited Shambat and Wad Medani from 26th February to 2nd March 1960.

THE GEZIRA RESEARCH STATION

BY

M. F. ROSE, A. LOW and R. C. FAULKNER

Survey of the Season

The most striking feature of the 1959-60 season was the very high total rainfall (555·7 mm.) and its abnormal distribution. A very dry period up to 20th July was followed by prolonged and intensive rains until 25th August causing flooding, excessive weed growth and difficulty in planting. A dry spell which followed enabled weeding to be done, but this was ended on 10th September by a fall of 72 mm. in 12 hours which again caused prolonged flooding and resulted in depleted stands through stem rot (*Macrophomina phaseoli*). Thus by the end of September, growth was very irregular, with plants stunted and chlorotic in appearance and many areas still showing the effects of severe waterlogging: it was not until mid October, following re-ridging, that the crop showed signs of improvement and assumed normal growth.

October and November were relatively cool and pleasant. December was mild and equable; it was not until 28th December that the so-called winter season commenced. Had it not been for such favourable conditions so late in the season, very poor yields would have been recorded for this late planted crop. By 26th January the crop had opened very rapidly and picking was virtually completed on the station by 21st March, despite the fact that planting dates ranged from 7th August to 2nd September. A remarkable feature of the season was the absence of leaf fall and senescence, the crop remaining green and healthy up to the last pick. Boll weights were above average (Domains Sakel, 2·8 gm.; X1730A, 2·9 gm.), but they did not reach the high level of the record season 1956-57.

Blackarm appeared on experimental plots in late September and all Ashmouni lots were badly affected. Resistant strains (B_2B_3) showed a measure of infection but these grew away from the disease later in the season. In general the effects of blackarm were very light and could not have depressed final yield. Leafcurl, which appeared on the station as early as 12th October, did not spread and all susceptible Sakel types were virtually free from the disease: even the new growth on cut back guard rows showed no symptoms. Wilt disease was also absent and the main Gezira areas reported a wilt-free crop.

Whitefly made its appearance on experimental plots about 20th September and, judging by the build-up of this pest on fallow weeds, a very heavy migration to cotton was expected. In fact, however, the build-up on cotton was light and there was a marked fall-off in population density from 12th November as a result of the control of the pest by *Eretmocerus* spp..

Jassid attack was severe throughout the season and persisted up to the end of February on the late sown cotton. The mild November and December doubtless favoured the pest and all glabrous American cottons and types carrying American 'blood' were severely attacked. A single spray with DDT afforded only temporary control and a second spray will have to be seriously considered if the climatic trend is toward a milder November and December (see Progress Report 1958-59).

Flea beetle wiped out isolated areas of early planted cotton and some valuable material was lost. The attack was favoured by the early dry period and the later flooding prevented control by insecticides.

Thrips were in evidence but damage was only noticeable on the later sown crop.

The 40 feddans of Sakel on the G.R.S. averaged 2·9 kantars of seed cotton (871 lb. per acre) and the 79 feddans of X1730A 4·2 kantars (1,258 lb. per acre).

TABLE 1
METEOROLOGICAL DATA G.R.S., 1959-60

Date	*Mean max.* °F.	*Mean min.* °F.	*Rainfall* mm.	*Humidity* 8 a.m.
April 1959	107 (108)	72 (77)	Trace (3·7)	18 (24)
May	108 (107)	76 (77)	2·9 (25·7)	29 (31)
June	105 (101)	76 (77)	31·3 (40·4)	48 (56)
July	97 (93)	74 (72)	160·8 (212·4)	68 (77)
August	88 (91)	71 (72)	273·3 (115·4)	86 (78)
September	93 (97)	71 (72)	82·6 (42·0)	75 (67)
October	100 (102)	70 (71)	4·4 (—)	54 (44)
November	98 (100)	66 (68)	— (—)	36 (41)
December	93 (95)	59 (62)	— (—)	43 (40)
January 1960	91 (91)	56 (57)	— (—)	39 (34)
February	97 (90)	61 (56)	0·4 (—)	30 (23)
March	99 (100)	62 (63)	— (—)	16 (19)
		Total	555·7 (439·6)	

Figures in brackets are those of the previous season.
Total rainfall 1st July-15th August 1959=340·7 mm.

BREEDING: EGYPTIAN TYPES

B_2B_3 S × L Material

The objectives of this work have been defined in previous reports and the results to date already referred to briefly above. The release of a Sakel type with B_2B_3 genes for resistance to bacterial blight, resistance to leafcurl, and lint quality and yield far superior to Domains Sakel, awaits only further testing at Shambat to confirm the leafcurl resistance. With the L type, material with B_2B_3 genes and superior to X1730A in quality and yield is now available. In this work, which involved a total of 444 progenies, special emphasis was laid on selection for low node number, a high earliness index (from picking data), boll weight and conformity to plant type. Lint assessment was made both on the variety trial bulks and on the parallel series of single plants stemming from the same families. This duplication, although involving considerable labour, provided a very useful check. Field, laboratory and Shirley Institute data, together with the graders' assessment (hand stapling), were all involved in making the final selections.

Pima S1 × BAR 14/25 (P Series) and Blackarm Resistant Pima S1 (PV Series)

Two hundred and eighty-three progeny rows of F3 material from the Pima S1 × 14/25 cross and twenty-four progeny rows of blackarm resistant Pima S1 were subject to detailed examination in both the field and laboratory. The original object of the cross (P series) was to transfer both earliness and lint quality from Pima S1 to the Sakel type. The basis of field selection was identical with that of the B_2B_3

S × L crosses but in all cases selection was made for Sakel habit. A wealth of variability was evident in this F3 material and it was relatively easy to pick out desirable rows for single plant selection. The examination of seed cotton and lint was undertaken by the Sudan Gezira Board graders and it was possible finally to pick out two distinct groups, one definitely better than Sakel and one at least equal to it. The groups contained 16 and 21 progeny rows respectively and natural seed from them will go into variety trials in the coming season.

The blackarm resistant series (PV) of Pima S1 contained 24 progeny rows and these all conformed to the Pima S1 type. Four years ago in the face of possible water shortages Pima S1 was considered a likely replacement of Sakel and, in consequence, it was urged that blackarm resistance should be transferred to it with all speed. The material on hand (ex Shambat) carried B_2 or B_2B_3 and it was necessary to check on Pima quality following the transfer.

Two groups have emerged from the season's work classed as V.G. Pima S1 and G. Pima S1, containing 4 and 5 progeny rows respectively. Natural seed from these nine lots will be tested in small scale trials in the coming season. It was noted that all 24 rows of the PV series were far more regular than the parental stock Pima S1 (J.B.H.).

Blackarm Resistant Synthetic Types (S and L)

Duplicate progeny rows amongst which controls were liberally dispersed were grown of the following types:

Sakel types:—BAR 14/48 (9 lots), BAR 14/49 (12), BAR 14/50 (9), all $B_2B_3B_6$; BAR 14/51 (6), B_2B_3; BAR 14/38 (1), BAR 14/40 (1), and BAR 14/41 (1), all B_2B_6.

L types:—BAR 4/25 (7) and BAR 4/25.H (107), all $B_2B_3B_6$; BAR 4/23 (1), B_2B_6.

Following quality assessment (hand stapling) coupled with yield trials and spinning test data over the years, it is now possible to reduce this material and in the coming season run comprehensive trials in which the best strains (of varied genetic constitution) will be directly comparable, rather than the very large number of very small scale trials in which only strains within families have been compared with the control. A dearth of B_2B_6 material in both S and L types will be remedied next season.

BLR 14/16 (B_2B_3) and BAR Karnak (B_2B_3)

In view of the fact that little interest has been shown in these two varieties, single plant selections from them will be stored. All seven families of BAR Karnak selected for strength of stem in 1958-59 have again shown this character and it is hoped that a similar strength component will be conferred on the Ashmounis following the transfer of blackarm resistance.

Acknowledgment is made to the Sudan Gezira Board graders (especially to Mr. J. Gibson) who have made the scope of this work possible.

Trials of Ashmouni Types

Ashmouni Spacing Trial

The lint yields shown in Table 2 indicate that with a closer intra-row spacing the two Ashmounis, A34 and Z10, can compete successfully with the standard types at standard spacing. Ashmouni 34 spaced at 17·5 cm. has outyielded BAR XL1 and BAR 14/25 at 35 cm. by 8·5% and 21% respectively; within the Ashmounis close spacing has outyielded standard by 14·5%, the closer spacing giving a better quality lint.

Although lodging must still be considered a serious defect in the Ashmounis, it can be partially offset by closer spacing in the absence of nitrogen. A34 has been acclaimed by all visiting delegations as the best Ashmouni on the world market to-day, and in consequence will be expanded at Wad en Nau in the coming season from the 10 feddan RR nucleus which averaged 5·7 kantars of seed cotton (1,712 lb. per acre) of excellent quality.

Table 2

Ashmouni spacing trial G.R.S.

Yields of seed cotton and lint in lb. per acre

Variety and spacing	*S.C.*	*Lint*	*Gin %*
Z10 (35 cm.)	1556	557	35·8
Z10 (17·5 cm.)	1732	632	36·5
A34 (35 cm.)	1479	531	35·9
A34 (17·5 cm.)	1701	614	36·1
BAR XL1 (35 cm.)	1526	566	37·1
BAR 14/25 (35 cm.)	1620	507	31·3
S.E.		±33·1	

Three randomized blocks, effective plot size 0·014 acre.

The spacings, 35 cm. and 17·5 cm., were intra-row; the between row spacing was 80 cm. throughout.

Planting was on 28th August and picking from 21st January to 10th April.

Russian Ashmounis versus 'Local' Ashmounis

Owing to a shortage of Russian seed, this trial was spaced at 35 cm. (intra-row). Yields generally were low (see Table 3) with the two Russian types very disappointing. Their lint was slightly longer and finer than A34 but in strength they were inferior. In view of the fact that both types lodged very badly, there seems little point in carrying forward this material. Seed from the bulk selfing of one replication will be stored.

TABLE 3

RUSSIAN ASHMOUNI TRIAL G.R.S.

Yields of seed cotton and lint in lb. per acre

Variety	*S.C.*	*Lint*	*Gin %*
Z10	1244	438	35·2
A34	1185	416	35·1
Russian N504B	851	279	32·8
Russian N2365B	759	283	37·3
S.E.		±29·3	

Four randomized blocks; plot size 0·0056 acre.

Planted 27th August, picked 21st January to 10th April.

GEZIRA STANDARD VARIETY TRIALS

The standard variety trials were planted at Turabi (North), Gezira Research Station (Centre) and Hag Abdulla (South) on 13th, 17th and 21st August respectively. The design of each trial was a randomized block of 10 replications, effective plot size 0·016 acre, with spacing standard at 80 × 35 cm.; three plants per hill were left at final thinning.

Germination and emergence were good and final stands satisfactory. Blackarm was absent from all three trials and slight leafcurl was recorded at Turabi only. The infestation of whitefly at all three sites was below average but jassid attack was severe, especially in the Centre and South. Acala 4.42 was severely damaged and to a lesser degree the three Pima S1 lots. It is now very evident that if glabrous Americans are grown, or types carrying American 'blood', then a second spray against jassid is essential to guarantee commercial success. Yields were average—they should have been much higher had jassid been effectively controlled.

In terms of lint yield there was little to choose between Domains Sakel and the BAR derivatives from it. The increase shown by BAR 14/25.4 over BAR 14/25 was slight but appeared at all three sites. BAR XL1 consistently outyielded X1730A, but these differences were not great. The three Pima S1 introductions, tested for the first time in these standard trials, gave relatively poor yields but final judgment must be withheld in view of the devastating jassid attack. Pima S1 (J.B.H.) gave higher lint returns per acre than Domains Sakel in the North and Centre and its quality was assessed superior to that of Sakel at all sites. Seed cotton and lint of all three Pima lots were stapled by the graders who gave first place to Pima S1 (J.B.H.), second to Pima S1 (W.E.N.) and third to Pima S1 (F.A.O.). This order held at all three sites. Acala 4.42, another introduction, gave an

Table 4

Gezira standard variety trials, 1959-60

Yields of seed cotton and lint in lb. per acre

The yields recorded include the produce of late secondary growth of Acala 4.42 and Punjab 268F at Hag Abdulla and Turabi but not at G.R.S. The addition of this late produce at G.R.S. would have increased the lint yield of Acala to 573 lb. and Punjab to 797 lb.

Variety	*BAR Genes*	*Turabi (North)*			*G.R.S. (Centre)*			*Hag Abdulla (South)*			*Overall means*		
		S.C.	*Lint*	*Gin %*	*S.C.*	*Lint*	*Gin %*	*S.C.*	*Lint*	*Gin %*	*S.C.*	*Lint*	*Gin %*
Domains Sakel	—	1729	536	31·0	1536	496	32·3	1656	525	31·7	1640	519	31·6
BAR 14/25	B_2B_2	1625	494	30·4	1547	498	32·2	1625	481	29·6	1599	491	30·7
BAR 14/25.4	B_2B_2	1690	512	30·3	1553	500	32·2	1628	485	29·8	1624	499	30·7
X1730A	—	1715	602	35·1	1579	578	36·6	1922	661	34·4	1739	614	35·3
XL1	B_2	1776	618	34·8	1632	594	36·4	1951	671	34·4	1786	628	35·2
Pima S1 (W.E.N.)	—	1701	570	33·5	1472	508	34·5	1025	322	31·4	1399	467	33·4
Pima S1 (J.B.H.)	—	1819	584	32·1	1585	539	34·0	1436	471	32·8	1613	531	32·9
Pima S1 (F.A.O.)	—	1789	592	33·1	1405	482	34·3	1072	356	33·2	1422	477	33·5
Acala 4.42	—	1800	720	40·0	1139	466	40·9	1663	657	39·5	1534	614	40·0
Punjab 268F	B_2+	2804	959	34·2	1888	676	35·8	2435	828	34·0	2376	821	34·6
S.E.			±14·5			±21·4			±17·2				

Table 5

Summary of performance of current strains in Gezira variety trials up to and including season 1959-60

Seed cotton and lint yields in lb. per acre and as a percentage of two control types

Variety	Basic type	Seed cotton						Lint					
		No. of trials	Mean			Variety as % of		No. of trials	Mean			Variety as % of	
			Variety	X1730A	DS	X1730A	DS		Variety	X1730A	DS	X1730A	DS
Northern Gezira													
Domains Sakel	—	21	1293	1321	1293	98	100	21	412	471	412	87	100
BAR 14/25	B_2B_3	10	1447	1495	1461	97	99	10	449	530	468	85	96
BAR 14/25.4	B_2B_3	4	1349	1448	1365	93	99	4	402	498	421	81	95
X1730A	—	21	1321	1321	1293	100	102	21	471	471	412	100	114
XLI	B_2	16	1386	1431	1413	97	98	16	490	509	454	96	108
Acala 4.42	—	1	1800	1715	1729	105	104	1	720	602	536	120	134
Punjab 268F	B_2+	1	2804	1715	1729	163	162	1	959	602	536	159	179
Pima S1 (W.E.N.)	—	1	1701	1715	1729	99	98	1	570	602	536	95	106
,, (J.B H.)	—	1	1819	1715	1729	106	105	1	584	602	536	97	109
,, (F.A.O.)	—	1	1789	1715	1729	104	103	1	592	602	536	98	110
Central Gezira													
Domains Sakel	—	34	1477	1724	1477	86	100	34	467	607	467	77	100
BAR 14/25	B_2B_3	10	1478	1545	1363	96	108	10	462	548	436	84	106
BAR 14/25.4	B_2B_3	4	1469	1577	1444	93	102	4	453	545	448	83	101
X1730A	—	34	1724	1724	1477	100	117	34	607	607	467	100	130
XLI	B_2	18	1619	1540	1312	105	123	18	571	549	419	104	136
Acala 4.42	—	1	1139	1579	1536	72	74	1	466	578	496	81	94
Punjab 268F	B_2+	1	1888	1579	1536	120	123	1	676	578	496	117	136
Pima S1 (W.E.N.)	—	1	1472	1579	1536	93	96	1	508	578	496	88	102
,, (J.B.H.)	—	1	1585	1579	1536	100	103	1	539	578	496	93	109
,, (F.A.O.)	—	1	1405	1579	1536	89	91	1	482	578	496	83	97
Southern Gezira													
Domains Sakel	—	17	1459	1620	1459	90	100	17	458	566	458	81	100
BAR 14/25	B_2B_3	10	1496	1632	1448	92	103	10	447	562	449	80	100
BAR 14/25.4	B_2B_3	4	1793	1960	1810	91	99	4	530	661	550	80	96
X1730A	—	17	1620	1620	1459	100	111	17	566	566	458	100	124
XLI	B_2	17	1564	1489	1290	105	121	17	544	517	407	105	134
Acala 4.42	—	1	1663	1922	1656	87	100	1	657	661	525	99	125
Punjab 268F	B_2+	1	2435	1922	1656	127	147	1	828	661	525	125	158
Pima S1 (W.E.N.)	—	1	1025	1922	1656	53	62	1	322	661	525	49	61
,, (J B.H.)	—	1	1436	1922	1656	75	87	1	471	661	525	71	90
,, (F.A.O.)	—	1	1072	1922	1656	56	65	1	356	661	525	54	68

average yield (about 6 kantars) at Turabi, but this performance was not repeated in the Centre and South where jassid attack was very severe. Punjab 268F has again demonstrated its very high yield potential under irrigation and this variety must be seriously considered as a source of raw material for local industry. Table 4 shows data from these trials, and Table 5 the performance of current strains. Grade was not as good as in 1958-59; Table 6 shows averages for the standard varieties.

TABLE 6

AVERAGE GRADE. STANDARD VARIETY TRIALS, 1959-60

	DS	*BAR 14/25*	*BAR 14/25.4*	*X1730A*	*BAR XL1*
Turabi	3·73	5·21	3·77	3·88	3·98
G.R.S.	4·57	5·18	5·78	5·10	4·29
Hag Abdulla	5·25	5·96	6·05	5·20	5·59
Mean	4·48	5·45	5·20	4·73	4·62

VARIETY TEST IN NORTHERN PROVINCE

The Northern Province trial, sited at Gendettu, was planted in mid May. Apart from P268F, yields were very low, that of the new introduction Acala 4.42 being below expectation. The trial was subject to severe and prolonged bollworm attack and unless these pests are controlled it is questionable whether cotton growing can be profitable in this area.

TABLE 7

GENDETTU VARIETY TEST, 1959-60

Yields of seed cotton and lint in lb. per acre

Variety	*S.C.*	*Lint*	*Gin %*
BAR 11/7	211	65	30·7
Wilds Sus 16/1	275	89	32·4
P268F	1094	359	32·8
Acala 4.42	603	227	37·7
S.E.		±17·8	

Ten randomized blocks, effective plot size 0·026 acre.
Spacing 75 cm. × 25 cm., 3 plants per hole.
Planted 14th May, picked 22nd August to 3rd October.

SEED DORMANCY

Much concern was aroused in the Zeidab area by the tardy germination and emergence of Acala 4.42 seed. This seed, first 'wave' from the Gondal area of the Sudan Gezira Board, was showing only 50% germination in 25 days and seedlings were still emerging one month from planting. The original seed, introduced from the U.S.A. in 1958 and planted on 1,200 acres at Gondal, had given excellent germination and there was no reason to suppose that the 1959 Zeidab seed had been damaged in any way.

Certain lines of Acala exhibit 'hard seed coat' and it was thought possible that a change of environment might have induced a greater proneness to this defect. Accordingly in mid August Acala 4.42,

Pima S1 and Domains Sakel were given the 'hot water' treatment (77° C. for 75 seconds) and this seed (with controls) was planted out in the field in small replicated trials and a parallel series planted in pots in the laboratory. All lots, including untreated controls, germinated and emerged equally well and by 14 days the average germination percentage was 85%. There was no indication of delayed germination here nor in bulk fields planted normally on the G.R.S. and at Gondal.

A probable explanation is that Acala 4.42 requires a specific dormancy period which is not satisfied when picking continues in the Gezira until the end of March and planting at Zeidab takes place in mid May.

Breeding and Testing: American Types (A. Low)

Variety Trial of Multiline Strains and Introductions at G.R.S.

Multiline admixtures representing various locally bred synthetic types were tested under irrigation at the Gezira Research Station in comparison with a number of introductions. Details of the material included are given below with comment on the results, which are presented in detail in Table 8. These results, in conjunction with those from the Nuba Mountains presented in Table 17, confirm that in the BAR HOP series types have been bred with the yield of BAR 7/8.2 and the quality of BAR 11/7; at the same time blackarm resistance (B_2B_3) has been retained.

BAR HOP 7 and BAR HOP 11.—These multiline strains result from the transference of the intrinsic fibre strength of a high strength line of Hopi Acala 46-124 to BAR 7/8.2 and BAR 11/7. The combination of high yield and high quality in each of these was confirmed; the lint was examined by staff of the Sudan Gezira Board and their findings supported by spinning test results.

BAR Wilds 36 and 40.—These were bred by transferring the large boll of Wilds Sus 16/1 to BAR 11/7 followed by selection which gave two lines having effective lengths (32nd. inch) of 36 and 40. In small scale trials individual strains from this material gave even more striking increases over BAR 11/7 in yield. New multiline mixtures made up from these will be serious competitors with BAR HOP 11 as strains closing the gap between the high yielding and the better quality types of the past.

BAR 11/9.—This, which is similar to BAR 11/7 but carries, in addition to B_2B_3, the gene B_6, gave a yield increase of 12% over BAR 11/7 but requires further improvement in both yield and quality.

Acala 4.42.—This, normally a high yielding variety, was more severely checked by waterlogging in the early stages of growth than other types in the test, except Wilds Sus 16/1, and gave an unusually low yield though maintaining its high ginning percentage.

TABLE 8

AMERICAN VARIETY TRIAL G.R.S. 1959-60 (Irrigated)

Variety	*Source*	*Node No.*	*Boll maturation period (days)*	*Boll weight (gm.)*	*Lint length mean max. (mm.)*	*Gin %*	*Yield in lb. per acre*		*Lint yield as % of BAR 11/7*
							S.C.	*Lint*	
BAR HOP 11	Sudan	8·3	53	3·8	35·9	33·7	947	319	124
BAR HOP 7	,,	8·8	53	4·1	37·0	36·3	1012	367	143
BAR Wilds 36	,,	8·3	55	3·6	36·7	33·7	910	301	117
BAR Wilds 40	,,	8·3	57	4·1	40·4	34·2	932	319	124
BAR 11/7	,,	8·4	53	3·4	36·2	32·0	802	257	100
BAR 7/8.2	,,	7·7	55	3·2	38·3	36·5	909	332	129
Hopi Acala (46-124)	U.S.A.	8·1	48	4·1	36·5	32·9	646	212	83
Wilds Sus 16/1	Sudan	7·9	59	4·1	44·3	34·7	778	270	105
BAR 11/9	,,	9·0	55	3·3	37·2	31·0	928	288	112
Acala 4.42	U.S.A.	7·9	55	4·9	38·9	40·6	873	355	138
BP52(11MB)	Uganda	8·4	55	2·9	40·3	32·2	880	283	110
BP52(NC59)	,,	7·6	55	3·2	40·7	32·7	988	323	126
BP52(57)3	,,	8·2	56	3·0	39·5	34·6	1125	389	152
Albar (A2MB)	,,	8·2	56	3·4	37·0	34·5	1039	358	140
UPA(57)17	,,	8·4	56	3·3	39·5	36·3	1012	367	143
Albar A(57)12	,,	8·7	56	3·7	37·9	35·8	1223	438	171
S.E.								±16·6	

Eight randomized blocks, effective plot size 0·0028 acre.
Spacing 80 cm. × 35 cm.; thinned to 3 plants per hole.
Planted 4th August, picked over the period November to January.

Uganda varieties.—Progeny (57)3 from BP52 and A(57)12 from Albar outyielded all other varieties in the test including the other representatives of BP52 and Albar. The BP52 multiline seed issue NC59 gave a yield comparable with BAR HOP and BAR Wilds material but there are grounds for suspecting that Uganda types grown in the Gezira will not reproduce the high quality for which they are known in Uganda. It will be noted that the boll maturation periods, given in Table 8, are 55 to 56 days against 70 days for the same strains growing in Uganda.

Comparisons of Individual Strains

The tests described above were conducted with multiline admixtures. Studies of the separate components of these gave valuable information and revealed differences which can be exploited in further breeding work. The high tensile strength of the lint of BAR HOP 11 strain 9 was particularly noteworthy, being 35% superior to that of BAR 7/8.2 and enabling it to give spinning results at counts of 60's comparable with those of much longer cottons.

Strain 6 of BAR 11/9 appeared to be a particularly satisfactory derivative of BAR 11/7, with the gene B_6 combined with good yield and lint length.

Results from strains of B7/10 (a derivative of BAR 7/8.2) were not sufficiently promising to warrant continued work on this material.

Breeding of Storm Resistant Types

To satisfy local requirements a marked expansion in area of the American rainfed crop is expected. Labour is limited and some form of mechanised picking will therefore be needed. To this end crosses between the storm resistant American variety "Stormmaster" and local types were made several years ago and have reached the fourth generation. These include a cross with the high quality BAR 11/7, since Stormmaster itself is of poor quality. Selection for lines homozygous for B_2B_3 within this material is well advanced.

Investigation of Factors Affecting Grade

(J. E. Jackson and R. C. Faulkner)

Effect of Date of Sowing, Nitrogen and Phosphorus on Cotton Quality and Yield

An experiment was carried out to determine the effects of sowing date and treatment with nitrogenous and phosphatic fertilizer on cotton quality and yield, and to elucidate the cause of these effects, and of the differences in quality between the successive picks of cotton.

Sixteen treatments (four sowing dates with four fertilizer treatments at each sowing date) were arranged in a split-plot design with four replications, with an effective plot size of 216 sq. m., a spacing of 80 × 50 cm. between plant holes and three plants per hole.

The dates of sowing were 26th July, 25th August, 2nd September and 9th September. A more evenly spaced range of dates had been planned, but early and mid August planting was rendered impossible by serious flooding.

The fertilizer treatments were as follows:—

1. Control plots with no fertilizer (C).
2. Nitrogen applied as urea at a rate of 80 rotls N per feddan (2N).
3. Phosphorus applied as superphosphate at a rate of 80 rotls of P_2O_5 per feddan (2P).
4. Nitrogen plus phosphorus applied as urea and superphosphate (2N + 2P).

The yields and grades were determined for each pick from each plot. Throughout the season fortnightly plant samples were taken from each plot and the dry weights of stems, leaves and fruits, the number of buds and bolls, and the leaf area per plant were determined for each sample.

A record of daily evaporation was obtained from Piche evaporimeters suspended within the crop, and the air temperature within the crop was measured by continuously recording thermographs in screens seated on the ridges. On some plants in each plot all flowers were date-tagged and the resultant bolls were harvested separately.

Spinning and fibre tests are to be carried out on the main plot picks and the tagged bolls. It is hoped that it will be possible to interpret the data obtained in the light of the plant growth data and the climatic conditions during the boll maturation periods. As it will be some time before these results are available only yields and grades will be considered in this report.

Insect population on the experimental plots was controlled by the use of BHC, endrin and DDT. No sizeable infestations of jassid, whitefly or aphis were allowed to develop.

Results.—The effect of the treatments on yield is shown in Table 9. Differences between sowing dates were significant at the 1% level, and fertilizer differences at the 0·1% level. The earliest sowing date was significantly better than all other dates within the 2P and 2N + 2P treatments, but not significantly different from the second date within the 2N treatment or from the second and third dates within the control. At all sowing dates the yield of the nitrogen treatment was significantly greater than the yield of the control, whereas there was no response to phosphate treatment. The 2N + 2P treatment was significantly better than the control and phosphate treatments at all sowing dates, and did not differ significantly from the nitrogen treatment except at the second sowing date.

TABLE 9

SOWING DATE AND FERTILIZER TRIAL

Yield of seed cotton and lint in lb. per acre

Sowing date	C			2N			2P			2N + 2P			*Date means*		
	S.C.	*Lint*	*Gin %*	*S.C.*	*Lint*	*Gin %*	*S.C.*	*Lint*	*Gin %*	*S.C.*	*Lint*	*Gin %*	*S.C.*	*Lint*	*Gin %*
July 26th	1410	454	32·1	2401	754	31·4	1436	454	31·6	2473	761	30·8	1930	606	31·4
August 25th	1097	354	32·3	2166	680	31·4	923	302	32·7	1758	563	32·0	1486	475	32·0
Sept. 2nd	1073	348	32·5	1706	539	31·6	936	309	33·0	1869	600	31·7	1396	450	32·2
Sept. 9th	995	320	32·1	1620	528	32·6	1089	356	32·6	1656	532	32·1	1340	433	32·3
Fertilizer means	1144	369	32·3	1973	625	31·7	1096	356	32·5	1939	615	31·7	1538	491	31·9

Standard errors and least significant differences for use with lint yields above:

	S.E.	*L.S.D.* (5%)
Dates	26	83
Fertilizers	14	41
Fertilizers (within one date)	29	83
Dates (within one fertilizer)	36	109

TABLE 10

SOWING DATE AND FERTILIZER TRIAL

Average grades

Date	C	2N	2P	2N + 2P	*Date means*
July 26th	3·57	3·88	3·93	3·85	3·80
August 25th	4·04	4·34	4·21	4·36	4·24
Sept. 2nd	4·46	4·86	4·48	4·66	4·62
Sept. 9th	5·26	5·71	5·31	5·34	5·41
Fertilizer means	4·33	4·70	4·48	4·55	

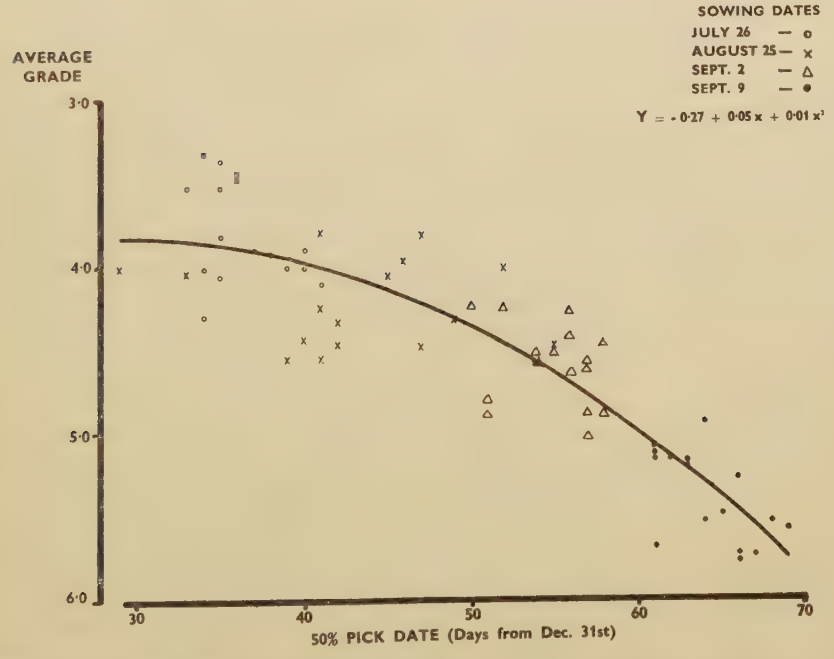
The effect of the treatments on average grade is shown in Table 10. Date of sowing had a very large effect, the earlier the sowing, the better the average grade of the crop. In comparison, fertilizer effects were slight, both nitrogen and phosphate giving rather lower average grades than the control.

Considering the experiment as a whole, crop earliness was the main factor affecting average grade. The earliness of each of the 64 plots was measured as its "50% pick date". The relationship between this and average grade is shown in Figure 1, which exhibits both the fall in

FIGURE 1

SOWING DATE AND FERTILIZER TRIAL

50% PICK DATE AND AVERAGE GRADE



grade with successive delays in planting and also the trend within each separate planting date. This latter is clearly similar in form to the between date effect and indeed, for the last sowing date considered

TABLE 11

SOWING DATE AND FERTILIZER TRIAL

Grade of individual picks (average of 4 replications)

Sowing date	*Treatment*	*Date of picking*								
		3.1	16.1	30.1	7.2	21.2	6.3	20.3	3.4	16.4
July 26th	C	3·00	2·88	2·88	2·63	4·13	5·50	6·50		
	2N	2·75	3·25	2·88	3·00	4·38	5·63	7·00		
	2P	3·00	3·13	3·75	2·63	4·25	5·50	6·25		
	2N + 2P	3·00	3·38	2·88	3·25	4·00	5·38	6·75		
August 25th	C		3·00	3·13	3·50	3·25	5·13	5·75		
	2N		3·00	2·88	3·38	4·88	6·50	7·25		
	2P		3·50	3·38	3·38	3·75	5·00	6·13		
	2N + 2P		3·25	3·75	3·50	4·75	5·75	6·75		
September 2nd	C			3·00	3·63	3·25	5·00	5·13	7·00	
	2N			3·50	3·50	3·88	5·38	5·88	6·63	
	2P			4·00	3·25	3·63	5·00	5·38	6·13	
	2N + 2P			3·50	3·25	3·63	5·38	5·75	7·00	
September 9th	C					4·25	5·25	5·63	6·25	7·00
	2N					4·88	5·13	6·25	6·25	7·00
	2P					4·25	5·38	5·50	6·38	7·00
	2N + 2P					4·63	4·75	5·75	6·25	7·00

separately, it is statistically significant. Differences in earliness accounted for over 70% of the total measured variation in average grade within the experiment, due to sowing date, fertilizer and plot effects.

The curvilinear nature of the regression, and the fact that the within sowing date effect is most obvious within the last date, suggest that the adverse effect of a delay in cropping becomes progressively more serious as the season advances.

One of the main aims of the experiment was to determine whether the early picks are of high quality because they comprise the first cotton produced by the plant, or because they are of cotton which has developed under more favourable environmental conditions than that included in the late picks. Table 11 shows the grade of each pick from each treatment (the average of four replications) and the date of picking. Environmental effects appeared to be predominant in determining grade. Fertilizer treatments had little effect on the grade of the individual picks and cotton picked at the same calendar date, i.e. which had developed under the same environmental conditions, was in general of similar grade.

Analysis of Other Grade and Quality Data

Data for the commercial varieties X1730A and Domains Sakel, grown in the Turabi, G.R.S. and Hag Abdulla variety trials over a number of years, were examined to determine whether seasonal variations in average quality could be accounted for by variations in crop earliness. The strength of the correlation (presented in Table 12) varied between sites and between varieties. Fluctuations in the 50% pick date had a greater effect on quality when the average 50% pick date was late (e.g. X1730A at Hag Abdulla) than when it was early (e.g. Domains Sakel at Turabi).

TABLE 12

CORRELATION BETWEEN EARLINESS AND SPINNING QUALITY IN VARIETY TRIALS, 1942-43 TO 1958-59

(*50% pick date correlated with count strength product*)

Variety	*Site*	*Average 50% pick date, mean of all seasons*	*Value of* r^2	*Significance of "r"*
X1730A	Hag Abdulla	10th Feb.	0·484	1%
	G.R.S.	5th Feb.	0·325	5%
	Turabi	4th Feb.	0·268	5%
Domains Sakel	Hag Abdulla	5th Feb.	0·296	5%
	G.R.S.	30th Jan.	0·001	N.S.
	Turabi	27th Jan.	0·082	N.S.

Thus for X1730A grown in the Southern Gezira variations in crop earliness have played a large part in determining seasonal variation in quality, whereas for Domains Sakel in the Northern Gezira this has not been shown to be the case.

These results were confirmed by analysis of data from the commercial crop. At Hag Abdulla X1730A has been grown in every season since 1939-40 and over this period seasonal variation in average grade has been highly correlated with variation in crop earliness ($r = +0{\cdot}654^{**}$), i.e. the later the crop the poorer its average grade. A similar relationship was shown for Fahl block. No appreciable correlation could be shown between changes in grade and in earliness since 1939-40 for the Domains Sakel grown in two Northern Gezira blocks, Turabi and Kab el Gidad.

The apparent lack of a consistent relationship between seasonal variation in earliness and grade at the Gezira observation plots noted earlier (Faulkner and Jackson, 1959) is thus explained as being due to site and variety effects.

The effects of site, nitrogen and spacing treatments on seed cotton grade were also investigated, using data obtained from Gezira observation plots between 1950-51 and 1958-59. Differences in the grade of cotton grown at the various sites were shown to be largely a result of difference in crop earliness, Turabi having the earliest crop and the best average grade, Hag Abdulla the latest crop and the poorest grade. Nitrogen treatment by increasing the yield of the poor quality late picks depressed average grade though it did not lead to a corresponding reduction in the yields of the better grades. Close spacing which led to the production of an earlier crop increased the yields of the medium grades.

Since earliness has been found to be of fundamental importance in determining quality, a detailed study is being made of factors controlling the rate of crop development within a season, and differences in rate of development between seasons. The relative growth rates, relative leaf growth rates, the ratios of leaf dry weight to total weight, and net assimilation rates throughout each season since 1940-41 have been calculated for X1730A and Domains Sakel, each grown at two nitrogen levels at two spacings at the Hag Abdulla observation plot. Analysis of the data from the other sites is proceeding. This work is being carried out in collaboration with the Statistician G.R.S. and it is hoped that it will lead to an understanding of the physiological basis of treatment effects on yield and of seasonal variation in yield, as well as in crop earliness.

Nucleus Renewal Programme

In this, the second season of the programme, preliminary selections were made from the BAR 14/25 variety, while work continued in the

second phase of the BAR XL1 programme.

BAR 14/25.—Single plant selections totalling 360 were taken in approximately equal proportions from bulks of BAR 14/25.4 Groups 1, 2 and 3, and BAR 14/25.5 Groups 1, 2 and 3, grown in isolation during the 1958-59 season. The selections were grown in three 11 × 11 lattice squares, each with 6 replications. All seeds were treated before planting with an Abavit/dieldrin preparation, and in contrast to the previous season, termite damage was negligible. The lattice design again proved more efficient than randomized blocks, the relative increase of information being 181%, 142% and 154% in the three trials. Selections were made on the basis of earliness and good total yield, and will enter the first year of the panmixis stage next season.

BAR XL1.—A bulk of the selections made in the previous season was grown in isolation and interpollinated by the brush method. A bulk of interpollinated bolls was harvested and will be planted in another panmixis bulk in the coming season. In addition, some of the selections included in the panmixis were grown as separate progeny rows in which further selection for earliness was made and selfed seed of selected plants retained.

SHAMBAT STATION

BY

S. O. S. DARK, J. H. SAUNDERS and N. L. INNES

Weather

The rains started late this season and were average in amount, the total being 12·7 in. The winter was long and very evenly cool, resulting in very good plant growth. The mean maximum temperatures ranged from 108° F. for May to 86° F. for January.

Resistance to Bacterial Blight

Field Test of Inoculum from Various Sources

A randomized replicated experiment was laid down in-season to compare the leaf lesion attacks produced by sprays prepared from Medani (2 year old) and Shambat (current season) trash, and also from pure cultures on nutrient agar of *Xanthomonas malvacearum* at different concentrations, on nine combinations of blackarm resistance genes with S, L and American varieties. Two of the nine varieties gave depleted stands due to poor germination and had to be omitted from the analysis. Spray differences, varietal differences and spray-varietal interaction were all significant at the 0·1% level. Comparable trash from Medani and Shambat could not be used because absence of

the disease from the Medani district meant that only stored trash was available.

Direct comparison between trash and culture sprays on a basis of number of bacteria per cc. is impossible because of the failure to obtain growth on the pure culture dilution plates. Shambat trash was significantly more virulent than Medani trash with equal numbers of bacteria per cc. Last year this virulence was equal, and the difference seems to be in the fact that 2-year-old trash had to be used from Medani while that from Shambat was produced in the current season. The pure cultures appeared to be of equal virulence. Actual counts were not available but it can be assumed that, since identical methods were used in the laboratory for producing the sprays from Medani and Shambat cultures, the sprays contained equal numbers of bacteria. Last season's results, and several trial runs, support the probability of this assumption.

Hence it would appear that storage has impaired either the virulence of the Medani bacteria or else the "booster" effect of trash on virulence of the bacteria.

Again it was impossible to differentiate between B_2 and B_2B_3 Sakel on mean leaf grade when trash spray was used. With Medani and Shambat culture sprays the mean leaf grade of B_2 and B_2B_3 Sakel did differ significantly at the 5% level. In the 1958-59 Report, p. 22, section 3, it is erroneously stated that for B_5 Sakel the Medani inoculum was 2 grades less virulent than that from Shambat. It was actually 2 grades *more* virulent. The results from the experiment this season show a much smaller difference in virulence between the Medani and the Shambat culture material; on average the difference was less than one grade, but it was still in favour of the Medani culture. With trash spray, however, both B_5 Sakel and B_5 Lambert were more resistant to Medani than to Shambat inoculum. This anomalous reversal is probably a result of using stored Medani trash.

Other Investigations of Virulence and Resistance

The results of two years' spraying experiments suggest that different strains of *Xanthomonas malvacearum* may occur in the Sudan, but only B_5 cottons have so far exhibited a differential leaf spot reaction to them, being more susceptible to the Medani one.

Strains of Sakel, Lambert and American cotton heterozygous for B_3 were sprayed with standard Shambat trash and graded. The grading gave no evidence that any breakdown of the B_3 gene had occurred, and a similar result was obtained when similar strains were tested in the glasshouse by needle inoculation of the main vein of the leaf with pure bacterium culture.

Experiments have continued with the leaf abrasion and needle inoculation techniques used in the glasshouse. By both methods

varieties carrying B_2 and B_2B_3 can be distinguished by differences in their mean measurements of the lesions produced, but the distributions overlap so that B_2 and B_2B_3 individuals in a segregating family still cannot be distinguished.

Numerous families have been tested in the glasshouse using the needle-prick technique. Homozygosity tests were made, and in accelerated B_2B_6 transferences, the resistant plants in backcrossed families were selected at an early stage and transplanted to the field for further backcrossing. Screening of test progeny in the transfer of B_6 by itself has also been carried out.

Families carrying B_6B_6 alone are expected to be fully susceptible. However, when B_6 was transferred to the fully susceptible stocks X1730A, DS and PSS and to Pima S1, which contains a few plants of low grade resistance, a proportion of the plants produced showed resistance of the order of grade "6". This suggests an interaction of B_6 with the residual genotype of the hybrid strains producing resistance not seen in either source alone. Lines homozygous for B_6 have been obtained from hybridizing with Pima S1, but the mean grade obtained was "6·5" and not "12" as expected.

In the transference of B_6 to B_2B_3 Sakel (BAR 14/49) an anomalous F_3 family, which bred true for resistance at a grade equal to that of B_2, was investigated and found to be homozygous B_3B_6. Table 13 shows the mean grades of various combinations of the factors in both homozygous and heterozygous phase.

TABLE 13

MEAN GRADES OF COMBINATIONS OF B_2, B_3 AND B_6

Genotype	*Family No.*	*Mean grade*	
		In season	*Out of season*
$B_2B_2B_6B_6$	BAR 14/41	2·5	2·2
$B_2B_2B_3B_3B_6B_6$	BA 916/59	0·9	2·1
$B_3B_3B_6B_6$	BA 1648-53/59	—	5·7
B_2B_2	BLR 14/16	6·8	5·7
$B_2b_2B_3b_3B_6b_6$	BA 917-8/59	4·1	2·4
B_3B_3	BAR 14/9	8·2	6·9
$B_3B_3B_6b_6$	BA 919-20/59	8·0	7·1
$B_2B_2B_3B_3$	BAR 14/25	7·5	4·3
$B_2b_2B_3B_3B_6b_6$	BA 921-22/59	4·0	2·4

The investigation of blackarm resistance factors transferred from *G. herbaceum* to Sakel continues. So far, no single genes for strong blackarm resistance have been isolated; the apparently "true-breeding" families began segregating again after two generations of inbreeding. There may still be useful major genes present.

Production of Resistant Varieties

Egyptian types.—The first cross has been made in transferring resistance to Ashmouni Z10 and the first backcross stage has been reached with Ashmouni 34. The Ashmouni family grown out-of-season to provide the backcross parents was found to contain 50% of plants showing grade 6-8 resistance: this resistant fraction is being used in the backcrossing programme. The third backcross generation has been reached with Pima S1.

Many other lines have been stopped and stored since adequate satisfactory material for a full programme of selection work at G.R.S. is already available, but a Lambert strain with B_2B_6 is being bred and BAR 14/52, a B_2B_6 Sakel, is being checked for homozygosity and, at the same time, rogued for resistance to leafcurl.

American types.—B 11/10, the latest $B_2B_3B_6$ form of Pump Scheme Strain, is undergoing a homozygosity check: transferences of B_2B_3 and B_2B_6 to Acala 4.42 have reached the 4th backcross stage: homozygosity tests on BAR Wilds with B_2B_3 are in progress and the sorting of various BAR HOP lines for resistance continues.

Resistance to Jassid

While the future of jassid resistant Sakels is still undecided, because of the apparent increase of infestation of whitefly on hairy plants, it was felt desirable to round off the information on three hairy strains. Two of these, BAJ 5/57 and BAJ 7/57, were grown in variety tests in the poor season 1957-58 when results were inconclusive, though the lint examiner's report was encouraging. These two strains are only moderately hairy and it was decided to include also strain J 1603/57, which has a dense long cover of hairs on all parts, with BAR 14/25 as control in a test in five randomized blocks with plot size 0·0056 acre. Results of this are given in Table 14.

Table 14

Trial of jassid resistant strains at Shambat

Yield of lint and ginning percentages

Strain	*Lb per acre*	*% BAR 14/25*	*Gin %*
BAJ 5/57	477	123	31·0
BAJ 7/57	566	145	34·1
J 1603/57	548	141	33·6
BAR 14/25	389	100	30·9
S.E.	±21·7	±5·6	

All three J strains were significantly better than control for lint yield and two of the three showed substantially higher ginning percentages. A considerable jassid population was observed and noticeable damage was seen on the non-hairy control BAR 14/25; a

fair measure of the yield increase must therefore be ascribed to the resistance of the hairy strains.

Spinning tests carried out by the Shirley Institute show that J1603/57 is short, weak and coarse and is therefore of no further interest. BAJ 5 and 7/57 on the other hand were both somewhat longer than BAR 14/25 although BAJ 5/57 was a little lower in fibre strength and BAJ 7/57 weaker and coarser. Selection from within the two BAJ stocks may provide an acceptable jassid resistant strain which could be used to advantage in specially chosen areas where jassid is a major problem.

Breeding for High Yield

The work of selecting and testing high ovule number strains, featured in the Progress Report of season 1958-59, continued. The 14 most interesting progenies selected out of earlier BAN material were grown at Wad Medani in three randomized blocks with plot size 0·0056 acre. The results are given in Table 15.

Table 15

Trial of selections for high ovule number

Yield of lint and ginning percentages

Strain	*Lb. per acre*	*% BAR 14/25*	*Gin %*
BAN 1/56.10	442	109	35·3
.19	495	122	34·3
.29	601	148	36·7
BAN 6/56.28	530	130	34·2
BAN 7/56.1	495	122	34·8
.5	601	148	35·9
.6	442	109	32·7
.9	530	130	34·3
.12	548	135	34·1
.18	548	135	35·5
.21	495	122	36·3
.25	601	148	35·0
.27	601	148	34·4
.29	407	100	33·2
BAR 14/25	407	100	31·7
S.E.	±49·0	±12·0	

These results are very encouraging and indicate that substantial advances in yield can be made by selection within BAN material; especially encouraging are the high ginning percentages. The lint of each progeny tested was examined by Mr. Gibson, lint examiner to the Gezira Board, who found that BAN 1/56.10 and 19, also BAN 7/56.12, were each fully equal to the control strain BAR 14/25. BAN 1/56.10 and BAN 7/56.12 were white linted, a quality which may prove important because it could affect assessment of grade. The remaining strains, while giving in many cases considerable advances upon BAR 14/25, were not considered to be of a sufficiently high lint quality to warrant further work.

At Shambat the 47 selected progenies from the season 1958-59 were tested in randomized blocks with six replications, each plot being half a ridge with about 30 plants. The total number of strains tested was 49, including as control BAR 14/25.4, considered to be the highest yielding selection out of BAR 14/25. The plant growth throughout the trial was disappointingly poor and, of the bolls to mature, at least half were damaged by pink bollworm. This led to low yields, the control, BAR 14/25, giving only 113 lb. lint per acre, and reduced the value of the comparisons. Nevertheless, the differences obtained between the strains under test and the control were so marked as to give confidence in the selection of types for further work. Thirty-three strains were significantly better than BAR 14/25.4 at the 5% level; 23 at the 1% level; 9 at the 0·1% level. The highest yielding strain gave 186% of control and extremely high ginning percentages were recorded ranging from 37·9% to 30·4% for BAR 14/25.4. All 33 high yielding strains were examined by the lint examiner. In comparison with BAR 14/25.4 he gave:

3 strains fully equal
6 strains good, fine
6 strains average
6 strains moderate

The "fully equals" in overall order of merit were, 2nd at 183% for yield, 15th at 157% and 32nd at 141%. There seems to be every promise here for future high yielding strains as good as BAR 14/25 for quality. Multiline strains made up from progenies within the grader's quality class assessment above will be tested at Wad Medani in the coming year. The best three strains will also be multiplied individually at Shambat.

Many single plant selections are being carried forward after screening for lint length and seed coat fuzz characteristics. The single plant selections from one family in particular, N99/59, are worthy of comment. Selection has been practised to produce a $B_2B_3B_6$ high ovule cotton. The lint from these plants was examined by the lint examiner, who pronounced it to be a better and finer staple than BAR 14/25 and, in addition, white in colour. Only those progenies with a minimal amount of seed coat hair or tuftiness are being carried forward and it is hoped that a high quality cotton with a capacity for high yield will emerge from this group.

Since abundant material is now available in the "high ovule" lines requiring assessment, single plant selection based upon ovule number will be discontinued. Future work will centre round the actual yield of progenies in terms of lint while the components of yield such as boll weight, number of seeds per boll and bolls per plant will be noted.

Resistance to Pink and Egyptian Bollworms

Two series of families have been developed in the attempt to transfer resistance into Pump Scheme Strain (*G. hirsutum*) from *G. thurberi* and *G. armourianum*. All families which had shown any indication of carrying resistance to bollworm were grown in a randomized and replicated experiment. Of the 28 families, three only (all ex *G. thurberi*) showed any promise of resistance this season, when plant growth was good and there was also a heavy attack by bollworm. Work on these will be continued. Because of the great decrease in number of bolls per plant over several seasons, a count of flowers and shed bolls was made, to check whether early bollworm attack on the flowers had caused shedding before bolls could develop. The shedding, however, appears to be a physiological characteristic of the Pump Scheme Strain and seems to be connected with the growing conditions of the season—this year showing an improvement on the previous one.

Studies of Wild Species

Investigations given in previous years' Progress Reports continue.

The hybrid *Notoxylinon australe* × *G. sturtii* has been successfully backcrossed to both parents and backcross families are now under cultivation.

The new species, *G. incanum*, from the Aden Protectorate, has been examined cytologically and has been found to have 13 pairs of chromosomes.

The work on *G. robinsonii* × *G. sturtii* is being written up for publication.

KADUGLI STATION

BY

M. F. ROSE, A. LOW AND HAMDAN EFF. HANNAY

The Commercial Crop

The 1959-60 season witnessed a further reduction in the cotton area in the Nuba Mountains: final purchases from an estimated area of 137,000 feddans amounted to 236,247 small kantars, a reduction of 59% on the previous season's return. Such a fall can be ascribed to the lower prices offered to the cultivator in the previous season but a below average rainfall, badly distributed, was also contributory. With a very marked fall in dura prices, the cultivator is not likely to abandon cotton but with the higher prices ruling for groundnuts and sesame the areas under these cash crops will probably increase at the expense of cotton.

Table 16

Rainfall at five stations in Nuba Mountains, 1959
(*in millimetres*)

Station	*April*	*May*	*June*	*July*	*August*	*Sept.*	*Oct.*	*Total*
Kadugli	—	40·0	41·0	160·0	199·5	75·0	57·0	572·5
Talodi	21·0	43·5	63·5	228·0	160·5	164·5	65·0	746·0
Abu Gubeiha	5·0	45·0	38·0	148·0	219·0	192·0	50·0	697·0
Dilling	29·0	22·0	128·0	208·0	168·0	128·0	50·0	733·0
Lagowa	32·0	10·0	136·5	145·0	243·5	94·0	46·0	707·0

In general, pest and disease attack was light, but flea beetle did extensive damage on the crop right up to the final pick. This increase in the spread and intensity of attack is a matter of concern, for flea beetle appears to be taking the place of the cotton leaf roller (*Sylepta derogata*) as a pest of major importance. Bollworms were in evidence up to the end of December with Sudan bollworm showing a peak infestation of 13% at Kadugli; this figure, however, does not represent the position in the Eastern Jebels where the attack was much more severe.

Variety Testing

Standard Series of Trials in Kordofan

The results of this series of five trials, each a Latin square of the same nine varieties, with plots of 0·0192 acre and spacing 90 cm. × 45 cm., 3 plants per hole, are given in Table 17. The most striking feature was the performance of BAR HOP 11 in comparison with BAR 11/7 at all five sites. As already noted (p. 1), this consistent improvement in yield, taken in conjunction with the results obtained under irrigation at G.R.S. (see page 12) and the information available regarding its lint quality, fully justifies the intention to multiply seed of this variety to use as replacement of BAR 11/7. In view of the achievement of this combination of high yield and good quality, the slightly higher overall average yield of Punjab 268F can be discounted: this variety will therefore be given no further consideration for rainfed areas.

"East African" Variety Trial at Kadugli

This trial contained seven types introduced from East Africa for comparison with two standard local commercial types in six randomized blocks. Good stands were obtained, growth conditions were good and pests and diseases virtually absent. The comparative yields given in Table 18 can therefore be accepted with confidence. No introduction outyielded the local varieties but grading (carried out by Sudan Gezira Board staff) suggested that the introductions were all superior to BAR 7/8.2.

TABLE 17

VARIETY TRIALS IN NUBA MOUNTAINS, 1959-60

Yield of seed cotton and lint in lb. per acre

Variety	*Dilling*		*Kadugli*		*Talodi*		*Lagowa*		*Abu Gubeiha*		*Overall mean*		
	S.C.	*Lint*	*S.C.*	*Lint*	*S.C.*	*Lint*	*S.C.*	*Lint*	*S.C.*	*Lint*	*S.C.*	*Lint*	*Gin %*
BAR HOP 7	736	262	817	263	794	254	470	157	341	114	632	210	33·2
BAR HOP 11	775	267	883	278	828	259	534	178	311	103	666	217	32·6
BAR 11/7	598	211	566	174	689	225	347	112	254	81	491	161	32·7
BAR 11/7.1 Group 1	685	243	683	214	773	243	492	164	299	99	586	192	32·8
BAR 11/7.1 Group 2	698	251	764	239	819	256	439	146	297	96	603	198	32·8
BAR 7/8.2	636	237	807	279	780	268	534	194	329	117	617	219	35·5
Wilds Sus 16/1	617	209	911	290	828	257	515	171	222	71	619	200	32·3
Punjab 268F	786	272	885	298	811	263	478	161	415	146	675	228	33·8
PSS	680	219	725	210	765	222	439	139	357	108	593	180	30·3
S.E. mean		±8·6		±10·6		±9·9		±6·9		±5·2			
Planting date	10th July		8th July		17th July		15th July		12th July				
Picking period	5th Dec. to 21st Jan.		14th Nov. to 6th Dec.		18th Nov. to 7th Jan.		9th Dec. to 2nd Jan.		26th Dec. to 28th Jan.				

TABLE 18
KADUGLI "EAST AFRICAN" VARIETY TRIAL, 1959-60
Yield of seed cotton and lint in lb. per acre

Variety	*S.C.*	*Lint*	*Gin %*	*Relative grade*
Uk48	770	226	29·4	5
Uk51	992	293	29·5	3
Uk55	818	245	30·0	4
55/38	861	255	29·6	5
55/106	850	264	31·1	5
55/253	781	226	29·0	5
1158	937	255	27·2	1
BAR 11/7.1 (Sudan)	987	302	30·6	2
BAR 7/8.2 (Sudan)	996	340	34·1	9
S.E.		±23·7		

Six randomized blocks, effective plot size 0·0105 acre.
Planted 8th July, spaced 90 cm. × 45 cm. with 3 plants per hole.
Picked over period 23rd November to 28th December.

Variety Trial at Tozi, Blue Nile Province

A Latin square with five varieties at this site had its first planting on 12th July wiped out by flea beetle. Replanted on 24th July it was again attacked and in spite of repeated spraying also suffered from persistent infestation by bollworms, chiefly the Sudan bollworm. The expansion of cotton growing in this area is reported to have been accompanied by an increase in the amount of stand-over cotton carrying pests.

Yields and quality were very poor; the highest yield, that of BAR 7/8.2, was only 156 lb. seed cotton per acre and varietal comparisons cannot be considered of any value.

Trials in Equatoria

With the Government fostering the expansion of the cotton crop on the East Bank of the Nile, it was decided that one of the Yambio trials should be transferred to the Torit area, the focal point of production in pre-war years. The two trials, at Torit and Yambio, were under the direct control of the Senior Inspector, Equatoria, and the Senior Research Officer, Yambio, respectively and acknowledgment is made to them for plot figures and seed cotton samples.

TABLE 19
VARIETY TRIALS IN EQUATORIA, 1959-60
Yield of seed cotton and lint in lb. per acre

	Yambio			*Torit*		
Variety	*S.C.*	*Lint*	*Gin %*	*S.C.*	*Lint*	*Gin %*
BAR 7/8.2	819	311	38·0	464	170	36·6
BAR 11/7	628	215	34·3	331	110	33·3
Punjab 268F	537	186	34·7	353	124	35·1
Wilds Sus 16/1	567	202	35·7	334	115	34·4
PSS	570	174	30·6	300	95	31·8
S.E.		±16·2			±8·0	
Effective plot size	0·030 acre			0·025 acre		
Planting date	2nd June			16th June		
Picking period	21st Oct. to 8th Dec.			19th Nov. to 15th Jan.		

Both experiments consisted of 7 randomized blocks and the spacing was 90 cm. × 30 cm.

Yields are given in Table 19: strain BAR 7/8.2 gave highest yields at both sites with Pump Scheme Strain bottom. The difference between BAR 7/8.2 and BAR 11/7 was greater than expected, but the latter outyielded PSS by 24% in seed cotton and 16% in lint. The yield of Punjab 268F was not high enough to compensate for its known poor quality.

In general, returns from Yambio were below average while those from Torit were poor. No figures are available for the incidence of pests and diseases within the crop, but judging by the seed cotton samples from Torit, it would appear that bollworms, stainers and *Helopeltis* were abundant. If this industry is to be placed on a sound economic basis, pest control will be one of the major problems to be solved.

Propagation

Yields from the Abu Habl Scheme and the Semeiha Extension, the main propagation area of BAR 11/7, were extremely low. This can be ascribed to the very late flow of the Khor Abu Habl which in turn delayed the normal planting date and considerably prolonged the operation. Cotton, following the rotational shift, was planted on irregular land and much was dried out and desiccated on the higher levels above the range of the ponding system. Thrips attack was also recorded and may have reduced yield still further. The 4,800 acres planted were reduced to an effective area of 2,598 acres and average yields were as low as 82 lb. per acre.

Small isolated propagation areas ($\frac{1}{4}$ acre each) of BAR HOP 11 and BAR HOP 7 were planted at Hajar El Mek, while BAR 11/7.1 Group 1 and BAR 11/7.1 Group 2 (2 acres each) were grown in isolation at El Effein. On the main farm Kadugli $1\frac{1}{2}$ acres of BAR 7/8.2 were grown, seed from which should be sufficient to start a 30-acre RR nucleus to replace that of BAR 7/8.1. The fate of this seed will be determined by future Government policy.

Publications

Rose, M. F.—'Cotton Research and the Development of the Commercial Crop in the Sudan'. Empire Cotton Growing Review, Vol. 36, No. 4, October 1959.

Saunders, J. H.—'The Wild Species of *Gossypium*'. Part II. Empire Cotton Growing Review, Vol. 36, No. 3, July 1959.

Saunders, J. H.—'The Wild Species of *Gossypium*'. Part III. Empire Cotton Growing Review, Vol. 37, No. 3, July 1960.

Appendix

Key to symbols used in this report

Egyptian S types.

DS	Domains Sakel originally imported from Egypt.
BAR 14/25	A Sakel type carrying B_2 and B_3 (formerly BLR).
BAR 14/25.4	4th filter for yield (formerly BLR).
BAR 14/48	The first Sakel type to carry $B_2B_3B_6$.
BAR 14/49	Successor type to BAR 14/48.
BAR 14/50	Successor type to BAR 14/49.
BAR 14/51	The B_2B_3 equivalent of BAR 14/50.
BAR 14/40	A Sakel type carrying B_2B_6.
BAR 14/52	A Sakel type carrying B_2B_6.
BAR 14/9	A Sakel type carrying B_3.
BLR 14/16	From the Sakel type BAR 14/7 (B_2) reselected for its leafcurl resistance.

Egyptian L types.

X1730A or XA	Successor type to X1730.
BAR XL1 BAR 1730L1	1st filter of BAR 1730L carrying B_2.
BAR 4/23	X1730A carrying B_2 and B_6.
BAR 4/25	An X1730A type carrying $B_2B_3B_6$.
BAJ lines	The hairy Sakel series, homozygous for B_2 and B_3 and carrying H_1.
BAN lines	A Sakel series stemming from the cross BAR 14/25 × *G. auritum*: ovule transfer for yield increase.

American Upland.

BAR SP84	The blackarm resistant component of Uganda SP84.
BAR 7/8.1 BAR 7/8.2	BAR SP84 carrying B_2 and B_3, 1st and 2nd filters.
BAR 7/10	BAR SP84 carrying B_2 B_3 and B_6.
Pump Scheme Strain (PSS)	An old commercial bulk derived from Nyasaland Upland.
BAR 11/5	XA129 (PSS) carrying B_2.
BAR 11/7	XA129 carrying B_2 and B_3.
BAR 11/9	XA129 carrying B_2, B_3 and B_6.
BAR 11/10	Successor type to BAR 11/9.
BAR 11/7.1	1st filter of BAR 11/7.
BAR Wilds 40	Stemming from the cross BAR 11/7 × Wilds Sus 16/1: 40 = effective length.
BAR Wilds 36	As above: 36 = effective length.
BAR HOP 11	A series emerging from the cross BAR 11/7 × Hopi Acala: very high intrinsic fibre strength transfer with marked yield increase.
BAR HOP 7	A series from the cross BAR 7/8.2 × Hopi Acala: high yield with quality improvement.
Wilds Sus 16/1	American long staple type: irrigated.
P268F	American importation direct from India.
Hopi Acala	A very early type directly imported from U.S.A. in 1953: of high intrinsic fibre strength.
Acala 4.42	A high quality American importation, 1955.
Pima S1 (J.B.H.) Pima S1 (W.E.N.) Pima S1 (F.A.O.) Pima S1 (Emb.)	Pima S1 stocks from different sources in the U.S.A.

A(57)12 Albar derivative (ex Namulonge).

Genes.

B_1 A weak dominant blackarm resistance gene from Uganda B31.

B_2 A strong dominant blackarm resistance gene from B31.

B_3 A partially dominant blackarm resistance gene from *G. punctatum*.

B_4 A partially dominant blackarm resistance gene from *G. arboreum*.

B_5 A partially dominant blackarm resistance gene from Grenadines White Pollen.

B_6 A blackarm resistance intensifier from *G. arboreum*.

B_7 A partially dominant blackarm resistance gene from Stoneville 20.

b_8 A recessive blackarm resistance gene from *G. anomalum*.

H_1 A hairiness gene from Tanguis.

H_2 A hairiness gene from *G. tomentosum*.

Sudan measures and weights.

1 feddan = 1·038 acres.
1 large kantar = 315 rotls.
1 small kantar = 100 rotls.
1 rotl = 0· 99 lb.

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PROGRESS REPORTS FROM EXPERIMENT STATIONS

The reports for the seasons up to and including 1950-51 were published in seasonal volumes; the following are still in print and available at 3/- per volume post free.

1923-25 (one volume), 1926-27, 1931-32, 1934-35,
1935-36, 1942-43 and 1945-46 to 1950-51.

From 1951-52 the reports from each territory were published individually each season. A few of the 1951-52 reports are out of print, but all others are available post free at 2/6 per report or £1 for the seasonal set.

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